



DIETARY MANAGEMENT IN POLYCYSTIC OVARY SYNDROME: REVIEW

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Article DOI: <https://doi.org/10.36713/epra14451>
DOI No: 10.36713/epra14451

ABSTRACT

Introduction: polycystic ovarian syndrome (PCOS) is an endocrine-gynecological disorder that affects and worsens the quality of life of women by altering their physiology and psychology in reproductive age. People with PCOS are more likely to develop insulin resistance, obesity, metabolic syndrome, systemic inflammation, or a combination of these chronic conditions. All of these conditions or diseases increase the risk of diabetes, cardiovascular disease, and other diseases. There are several methods to reduce the chances of suffering from these diseases, among which are proper dietary management, which is why this review has been developed, whose purpose is to gather the information available to date.

Objective: describe actual and available dietary treatments for polycystic ovary syndrome (PCOS).

Methodology: a total of 67 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 39 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Scopus and Web of Science; the MeSH keywords "Polycystic Ovary Syndrome" "Diet" "Treatment" and DeCS "Síndrome de ovario poliquístico" "Tratamiento" "Dieta" were used.

Conclusions: currently there are diets and supplements that have been rigorously investigated (through clinical trials) within which certain benefits have been observed with respect to body composition and biomarkers. Within these diets and supplements we find the following diets: ketogenic, mediterranean, low glycemic index, pulse-based, DASH and restricted feeding. At the moment, the number of studies, their magnitude and duration remain insufficient to guarantee reliable recommendations for patients, which is why it is essential that larger studies be carried out to guarantee adequate therapy for the benefit of patients.

Keywords: Polycystic Ovary Syndrome. PCOS. Diet. Dietary Treatment. Treatment. Hyperandrogenism.

INTRODUCTION

Polycystic ovary syndrome (PCOS) is an important cause of both menstrual irregularity and excess androgenic hormones in women, making it the most common endocrinopathy that affects this type of patient (1). Polycystic ovary syndrome can be diagnosed in different ways, but is most easily diagnosed when women present with classic features such as hirsutism, irregular menstrual cycles, and polycystic ovary morphology on transvaginal ultrasound (TVUS). At present there is considerable controversy over the specific diagnostic criteria when not all of these classic features are evident (2).

With respect to the treatment of PCOS, a large number of advances have been identified with respect to non-pharmacological management, and in some cases, it is possible to start with the implementation of exercise and a modification in diet as a first-line treatment (3).

METHODOLOGY

A total of 67 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 39 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Scopus and Web of Science; the MeSH keywords "Polycystic Ovary Syndrome" "Diet" "Treatment" and DeCS



“Síndrome de ovario poliquístico” “Tratamiento” “Dieta” were used.

The choice of articles was based on relevance to the contribution on polycystic ovary syndrome and its treatment and updates on the implementations of nutritional interventions for its management.

DEVELOPMENT

Overview

Polycystic ovary syndrome (PCOS) is one of the most common pathologies among women of reproductive age. This endocrine alteration, which affects 8-13% of the female population of childbearing age, presents great variability with respect to the symptoms that can manifest (4). Up to 70% of affected women remain undiagnosed worldwide (5).

Diagnosis

Although there are currently no agreed upon diagnostic criteria for adolescent polycystic ovary syndrome (PCOS), hyperandrogenism is essential for the diagnosis. All conditions that mimic PCOS should be ruled out before confirming the diagnosis of PCOS. Although obesity itself is not considered part of the differential diagnosis, obesity is associated with insulin resistance or any condition associated with severe insulin resistance, which may manifest clinically in the same way as polycystic ovary syndrome (6). Obesity can unmask characteristics of polycystic ovary syndrome in women genetically predisposed to this syndrome. The following pathologies should be considered in the differential diagnosis of PCOS (7,8):

- Hypothyroidism.
- Ovarian hyperthecosis.
- Drugs (androgenic progestogens, danazol).
- Congenital adrenal hyperplasia (late onset).
- Patients with menstrual disorders and signs of hyperandrogenism.
- Familial hirsutism.
- Idiopathic hirsutism.
- Cushing's syndrome.
- Tumors of the adrenal glands or ovary (rapid appearance of signs of virilization).
- Hyperprolactinemia.
- Stromal hyperthecosis (valproic acid).
- Use of exogenous anabolic steroids.

Treatment

The choice of treatment for PCOS depends on the type and severity of symptoms, the woman's age, and her plans for pregnancy (6,8).

Pharmacotherapy

Pharmacological treatments are reserved for so-called metabolic disorders, such as anovulation, hirsutism and menstrual irregularities. Medications for such conditions include oral contraceptives, metformin, prednisone, leuprolide, clomiphene, and spironolactone (9).

Non-pharmacological treatment

Certain lifestyle changes, such as diet and exercise, are considered first-line treatment for adolescents and women with

polycystic ovary syndrome (PCOS). The American College of Obstetricians and Gynecologists (ACOG) and the Society of Obstetricians and Gynecologists of Canada (SOGC) indicate that lifestyle modifications, such as weight loss and increased exercise, along with a change in diet, consistently reduce the risk of diabetes (10,11).

This approach has been found to be comparable or better than drug treatment and should therefore be considered first-line treatment in the treatment of women with polycystic ovary syndrome (PCOS). These modifications have been effective in restoring ovulatory cycles and achieving pregnancy in obese women with polycystic ovary syndrome. Weight loss in obese women with PCOS also improves hyperandrogenic characteristics (9,12).

Women with a BMI greater than 27 kg/m² are considered overweight and are often insulin resistant. Women with a BMI > 30 kg/m² are considered obese and almost always have insulin resistance. Weight loss, even 5% to 7%, can decrease the number of circulating androgens and will therefore induce ovulation. Weight loss is also associated with reduced insulin and testosterone levels and an improved lipoprotein profile. These patients generally have better outcomes when many members of a healthcare team, including a nutritionist, are actively involved in their care (13).

Dietary and Nutritional Management

Lifestyle modification, physical exercise, and especially dietary intervention focused on healthy weight loss, are considered the first line of treatment. Evidence shows that lifestyle changes with small goals achieve clinical benefits. Likewise, it is important to follow the corresponding pharmacological and/or hormonal treatment depending on the case (14).

The composition of the optimal diet for women with PCOS generally follows the pattern of the Mediterranean diet and it has been established that nutritional intervention should achieve not only short-term weight loss and improvement in symptoms and fertility, but also, reduce the long-term risk of type 2 diabetes mellitus, cardiovascular disease and other associated complications (15).

In general terms, the diet should limit the intake of saturated fat, include moderate amounts of monounsaturated fat, which does not induce harmful metabolic effects, and increase the intake of fiber and low glycemic index foods (16).

Weight reduction in women with PCOS has been shown to improve metabolic disorders and body composition, but there is no consensus on the ideal dietary pattern or macronutrient composition (17). Below are some of the dietetics proposals for the management of PCOS:

Ketogenic Diet (Keto diet)

The ketogenic diet (KD) is a low-carbohydrate diet that is rapidly showing promising benefits not only in obesity but also in the treatment of other metabolic diseases such as PCOS. This is demonstrated by some studies that reveal benefits ranging



from a reduction in BMI to a decrease and/or control of blood sugar and insulin levels and other biomarkers (18).

In the first of the studies reviewed, a ketogenic Mediterranean diet with phyoextracts (KEMEPHY) was applied for 12 weeks after which a decrease in both body weight (-9.43 kg) and BMI (-3.35) was observed. kg/m²), while in the laboratory tests a significant decrease in blood glucose and insulin levels was

observed, along with a significant improvement in HOMA-IR, on the other hand, a significant decrease was observed in the lipid panel of total cholesterol, triglycerides and LDL along with an increase in HDL levels. The LH/FSH ratio, total and LH-free testosterone, and blood DHEAS levels were also reduced but minimally (19). The composition of the diet used in the research is described below:

Table 1. KEMEPHY* Diet Composition

	g	% Total E	Kcal
Daily total energy			1672 ± 90
Carbohydrate	20.3 ± 5.2	4.8 ± 1.2	81.5 ± 18.9
Fat	132.4 ± 11.7	71.1 ± 9.3	1188.2 ± 100.2
Protein	100.8 ± 8.6	24.1 ± 5.6	403.4 ± 45.3
Fats distribution		% total fats	
Saturated		38.8 ± 6.9	
Monounsaturated		50.9 ± 6.5	
Polyunsaturated		9.7 ± 5.6	
Protein (g/Kg body weight)	1.23 ± 0.8		

*Mediterranean eucaloric ketogenic protocol (about 1600/1700 kcal/day) with the use of some phytoextracts.

Source: Paoli A, Mancin L, Giacona MC, Bianco A, Caprio M. Effects of a ketogenic diet in overweight women with polycystic ovary syndrome. *J Transl Med* (19).

Another study conducted in 2021 studied the ketogenic diet applied in patients with liver dysfunction, resulting in the KD group reporting a significant reduction in anthropometric characteristics and body composition. No significant differences were observed with respect to baseline hormones in contrast to the results at the end of the study. On the other hand, the KD group significantly reduced liver function markers compared to the control group ($p < 0.05$). Signs of fatty liver disappeared in six out of seven participants with fatty liver in the KD group after 12 weeks of intervention, while only one in 10 participants with fatty liver in the control group disappeared (20).

In another clinical trial carried out in 2022, the KD was compared with the Mediterranean diet, resulting in significant changes in anthropometric and biochemical parameters in both groups after both diet therapies, with statistically significant differences ($p < 0.001$). However, reductions in all parameters were significantly greater in the KD group than in the MD group (21).

Mediterranean Diet

One of the dietary interventions evaluated in women with PCOS is the Mediterranean diet (MD), which has been shown to have a benefit in trying to reduce body weight in addition to an anti-inflammatory effect. DM is based on the regular consumption of fiber, vitamins, antioxidants, as well as unsaturated fats, low GI carbohydrates and a moderate intake

of animal protein. The anti-inflammatory effect of this diet is attributed to the production of short-chain fatty acids derived from the microbiota induced by dietary fiber and the high intake of omega-3 polyunsaturated fatty acids and antioxidants (22). A 2019 study found that in the treatment of polycystic ovary syndrome, MD helped in reducing the inflammatory state demonstrated by a reduction in CRP ($p < 0.001$), insulin resistance, and hyperandrogenemia. In conclusion, a novel direct association between MD adherence and clinical disease severity was reported in women with PCOS (23).

Low Glycemic Index Diet

These diets are characterized by being composed mostly of carbohydrates with a low GI. This type of diet has become popular in the treatment of PCOS. Apparently, women with PCOS have a lower concentration of glutathione peroxidase than healthy women (24).

In a study carried out in 2010 in which patients were evaluated using the insulin sensitivity index derived from the oral glucose tolerance test (ISI OGTT), which improved ($p = 0.03$) more in the patients who followed a low-GI diet compared to patients who followed a conventional healthy diet (mean ± SEM: 2.2 ± 0.7 compared with 0.7 ± 0.6 , respectively). There was a significant benefit between diet and metformin ($p = 0.048$), with greater improvement in OGTT ISI among women prescribed metformin and a low-GI diet (25).



Table 2. Sample diets for the 2 dietary groups

	LGI diet ¹	CHD ¹
Breakfast	1 cup LGI cereal ²	1 cup high-fiber, high-GI cereal ³
	200 mL low-fat milk	200 mL low fat milk
	1 medium orange	1 cup diced rockmelon
Snack	1 medium apple	1 medium banana
Lunch	2 slices whole-grain bread ⁴	2 slices whole-meal bread
	50 g tuna in spring water	50 g tuna in spring water
	1 cup salad vegetables	1 cup salad vegetables
	50 g avocado	50 g avocado
Snack	2 LGI crispbreads ⁵	2 whole-meal crispbreads
	2 Tbsp hummus	2 Tbsp hummus
	4 slices tomato	4 slices tomato
Dinner	100 g lean pork	100 g lean pork
	2 cups mixed vegetables	2 cups mixed vegetables
	3/4 cup Asian noodles	3/4 cup brown rice ⁶
	1 tsp olive oil	1 tsp olive oil
	1 tsp soy sauce	1 tsp soy sauce
Snack	150 g low-fat fruit yogurt	150 g low-fat fruit yogurt
	1 small pear	1 cup diced watermelon
Energy (kJ)	6620	6590
CHO (%)	50	50
Protein (%)	23	23
Fat (%)	27	27
Dietary fiber (g)	34	32
GI (%)	40	59
GL (g)	74	109

1: LGI, low glycemic index; CHD, conventional healthy diet; GI, glycemic index; CHO, carbohydrate; GL, glycemic load. 2: Guardian; Kellogg's Australia, Sydney, Australia. 3: Bran Flakes; Kellogg's Australia. 4: Tip Top 9-Grain Multigrain bread; Tip Top Bakeries, Sydney, Australia. 5: Ryvita Multigrain Rye Crispbread; The Ryvita Company, Sydney, Australia. 6: Sunbrown Quick rice; SunRice, Leeton, Australia.

Source: Marsh KA, Steinbeck KS, Atkinson FS, Petocz P, Brand-Miller JC. Effect of a low glycemic index compared with a conventional healthy diet on polycystic ovary syndrome. *Am J Clin Nutr.* 2010 Jul 1;92(1):83–92 (25).

Pulse-Based Diet (PBD)

Some foods that contain high amounts of fiber are legumes such as peas, lentils, chickpeas and beans. This high amount of fiber gives them a low GI, they are also a food with high quality proteins, they are low in fat and are an essential source of micronutrients. In people without pathologies, it has been shown that this type of diet prevents or reduces IR (26).

In a study carried out in 2018, the effects of a diet based on low-glycemic index legumes were compared with the diet of therapeutic lifestyle changes (TLC) along 16 weeks in women with PCOS, obtaining the results that the PBD group had a better response on the 75 g oral glucose tolerance test, reduction in diastolic blood pressure, decrease in triglycerides, decrease in LDL, and a greater increase in HDL-C than the TLC group (27).

There is another very similar study carried out in 2020 that also compares a PBD with TLC but this time focuses on its impact on body composition and bone density. The results indicated that after 16 weeks, both groups had a reduction in BMI, total body fat mass and fat percentage, however decreases were observed in bone mineral density (BMD) of the femoral neck (28).

Restricted Feeding (Intermittent Fasting)

Al momento solo existe 1 investigación que de manera rigurosa analice este tipo de dieta. El estudio fue publicado en 2021 y analizó la evolución de 15 paciente durante 6 semanas a la cuales se les indicó que podía comer libremente de 8 am a 4 pm y que ayunaran de 4 pm a 8 am obteniendo al final del estudio cambio significativos en el IMC, BF%, grasa visceral, testosterona total, globulina fijadora de hormonas sexuales y resultados de glucosa en sangre (29).

DASH Diet

Within some of the research that analyzes the effects of the Dietary Approaches to Stop Hypertension (DASH) eating plan, we can observe 2 studies that contrast similar results. In the first, carried out in 2015, the DASH diet was applied for 8 weeks, obtaining a significant decrease in weight, body mass index, decrease in triglycerides and LDL cholesterol levels, in addition, higher concentrations of total antioxidant capacity were found. (TAC) and total glutathione (GSH) in the DASH group compared to the control group (30). On the other hand, the second study was carried out in 2015 and obtained the results that adherence to the DASH eating pattern resulted in a significant reduction in serum insulin levels, HOMA-IR score and serum CRP levels compared to the DASH diet. control;



Furthermore, a significant reduction in waist (-5.2cm; $p=0.003$) and hip circumference (-5.9; $p<0.0001$) was also observed in the DASH group compared to the control group (31).

Supplementation

There are currently some supplements that have been studied regarding their possible beneficial effect on PCOS. Some are cited below:

- **Vitamin D:** some studies indicate that the administration of 20,000 IU of cholecalciferol weekly for 24 weeks may be associated with a significant increase in 25-hydroxyvitamin D and a significant decrease in plasma glucose at 60 minutes during the oral glucose tolerance test (OGTT) (32).
- **Inositol:** regarding this supplement, there are 2 presentations that are usually used in patients who want to improve insulin sensitivity: Myo-inositol (MI) and d-chiro inositol (DCI). The main difference between these 2 is that myo-inositol helps with the activation of transporters and the use of glucose by the body, while d-chiroinositol participates in the synthesis and storage of glycogen (33). Some of the benefits that have been observed with the use of inositol are:
 - **Regulation of the menstrual cycle:** when patients were treated for 6 months with MI + ICD (550 + 150 mg, ratio 3.6:1) twice a day and CHC (ethinyl estradiol 20 μg + drospirenone 3 mg) once a day, it was observed a regulation in the cycles, which was maintained up to 3 months after finishing the treatment (34).
 - **Reduce insulin resistance and lipid profile:** intake of 2-4g myo-inositol for 12-24 weeks in women with polycystic ovary syndrome had beneficial effects on glycemic control, triglyceride and VLDL cholesterol levels and genetic expression of peroxisome proliferator (PPAR- γ) (35,36).
- **Curcumin:** some studies indicate that the consumption of 500 mg of curcumin three times a day could be related to a decrease in fasting plasma glucose (FPG) and dehydroepiandrosterone (37,38).
- **Magnesium and Zinc:** Reductions in inflammatory markers such as serum high-sensitivity C-reactive protein were observed when administered 250 mg of magnesium oxide plus 220 mg of zinc sulfate (containing 50 mg of zinc) twice daily for 12 weeks. (hs-CRP) and protein carbonyl (PCO) (39).

CONCLUSIONS

Currently there are diets and supplements that have been rigorously investigated (through clinical trials) within which certain benefits have been observed with respect to body composition and biomarkers. Within these diets and supplements we find the following diets: ketogenic, mediterranean, low glycemic index, pulse-based, DASH and restricted feeding. At the moment, the number of studies, their

magnitude and duration remain insufficient to guarantee reliable recommendations for patients, which is why it is essential that larger studies be carried out to guarantee adequate therapy for the benefit of patients.

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